STUDIES ON SOME SPECIES OF *HAKEA* (PROTEACEAE)

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Summary

MACONOCHIE, J. R. (1973).—Studies on some species of *Hakea* (Proteaceae). *Trans. R. Soc. S. Aust.* **97**(2), 127-133, 31 May, 1973.

Hakea standleyensis sp. nov. is described from Standley Chasm, central Australia. This species is allied to *H. collina* C. White of south-west Queensland but differs in leaf size and flexibility, and fruit shape.

An examination of collections under *H. multilineata* has led to the recognition of five species: *H. multilineata* Meisn., *H. francisiana* F. Muell. and *H. grammatophylla* (F. Muell.) F. Muell., and two new species, *H. minyma* Maconochie and *H. coriacea* Maconochie. *H. bucculenta* Gardn., which is allied to this group, is readily separated by its narrower uninerved leaves. The possible evolutionary origins of the species in the group are discussed in relation to their distribution.

1. **Hakea standleyensis** Maconochie sp. nov.

Frutex erectus diffusus, usque ad 1 m altus. *Folia* linearia, teretia, erecta, infirme pungentia, circa 1.5 mm diam., 30–65 mm longa (sed usitate 50–60 mm). *Inflorescentia* axillaris, racemosa, parva, 6–9-flora, rachide ca. 2 mm longa. *Flores* ca. 8–11 mm longi, per pilos longos sericeos albos villosa, perianthio 4–6 mm longo atque pedicello 4–5 mm longo. *Ovarium* glabrum paene sessile, ca. 1 mm longum; stylus glaber, ruber, ca. 9 mm longus; stigma late conicum, glabrum. *Torus* obliquus, glans rubra, semiannularis ad elongatam, ca. 1 mm longa. *Fructus* ca. 15 mm longus, late falcatus, ca. 5 mm latus (ad partem latissimam), pericarpo verruculoso, pedunculo ca. 10 mm longo. *Seminis corpus* obovatum, ad apicem attenuatum, ca. 5 mm longum; ala ca. 5 mm longa, reticulo tenui brunneo praedita.

Holotypus: *D. J. Nelson* 1556, Standley Chasm (23°41′S. 133°27′E), 53 km W of Alice Springs, N.T. 19.ix.1967 (NT).

Isotypi: AD, BRI, NSW.

Specimens examined (all from Standley Chasm). *Chippendale & Johnson* (NT 3997), 16.x.1957 (AD, BRI, CANB, K, MEL, NSW, NT, PERTH); *Maconochie* 464, 25.viii.1967 (NT); *Nelson* 1555, 19.ix.1967 (MEL, NT); *Must* 356, 9.xii.1968 (NT).

Erect straggling shrub up to 1 m high. *Leaves* linear, terete, weakly pungent-pointed, erect on stems, about 1.5 mm in diam. and (30–) 50–60 (–65) mm long. *Inflorescence* a small axillary raceme of 6–9 flowers, the rachis about 2 mm long, villous with long white silky hairs. *Flowers* about 8–11 mm long, perianth 4–5 mm long, pedicel 4–5 mm long. *Ovary* glabrous, almost sessile, about 1 mm long; style glabrous, red, about 9 mm long; stigma broadly conical, glabrous. *Torus* oblique; gland red, semi-annular to elongate, about 1 mm long. *Fruit* about 15 mm long, broadly sickle-shaped, about 5 mm broad at the widest point; pericarp verruculose, peduncle about 10 mm long. Seed-body obovate, tapering to apex; about 5 mm long; wing about 5 mm long with fine brown reticulations.

Habitat: on and in quartzitic rock ledges and crevices almost at summit of main outcrop at rear of Standley Chasm.

This species is endemic to the Macdonnell Ranges, central Australia, being found only at high altitudes at Standley Chasm. Chippendale (1963) discussed the relic nature of plants found in the Macdonnell Ranges and it is probable that *H. standleyensis* is a relic species, possibly on the verge of extinction.

H. standleyensis is allied to *H. collina* C. White (1944, p. 79) and also *H. microcarpa* R. Br. *H. collina* is found on the sandstone tableland of south-west Queensland and *H. microcarpa* is restricted to southern highland areas of eastern Australia and extends down to Tasmania. The three species may be separated as follows:

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(1) Perianth glabrous. Leaves terete or triquetrous ..... *H. microcarpa*

(1) Perianth villous. Leaves terete.

(2) Leaves flexible, (30–)50–60(–65)mm long, weakly pungent-pointed. Follicle about 15 mm long, 4–5 mm wide, incurved along ventral edge ..... *H. standleyensis*

(2) Leaves rigid, 20–40 mm long, strongly pungent-pointed. Follicle about 20 mm long, 6–8 mm wide, almost straight along the ventral edge ..... *H. collina*

II. Hakea multilineata and its allies

Bentham (1870) commented that he could see no major difference between the descriptions of *H. multilineata* Meisn. and *H. grammatophylla* (F. Muell.) F. Muell., except that the raceme of the latter species has a densely tomentose rachis. Bentham therefore considered *H. grammatophylla* as a variety of *H. multilineata*. Black (1948) followed Bentham. Bentham also placed *H. francisiana* F. Muell. under *H. multilineata* although he did not see

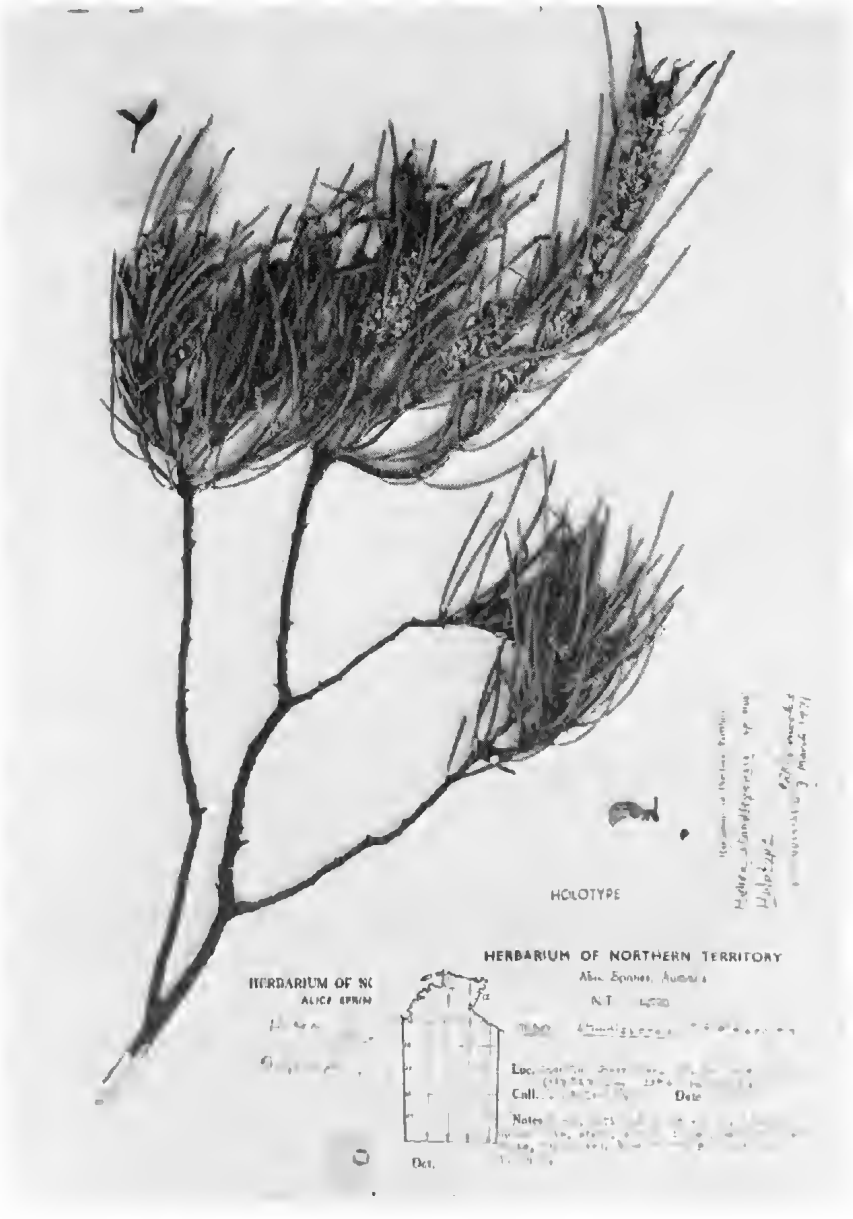

Fig. 1. Holotype sheet of *Hakea standleyensis* Maconochie.

any material of the first species. Eichler (1965) treated *H. francisiana* as a separate species.

To study this problem further, collections of this group of species were borrowed from the principal Australian herbaria and also two type sheets from Kew and New York Botanic Gardens. Data were compiled on inflorescence length, colour and texture, the shape and size of fruit and seed, and leaf dimensions and number of veins. The collections were initially sub-divided into six groups based on gross similarities and dissimilarities and then the mean and standard deviation of the number of veins per leaf (6 to 12 leaves per sheet) for each group calculated. A t-test was then applied to the data.

H. multilineata and its allied species have the following similarities: all are shrubs; leaves linear, flat with several to many nerves; inflorescence a many flowered raceme 2–10 cm long, enclosed in bracts at the bud stage; stigmatic cone long and narrow; fruit almost sessile.

In general, the flowers of *H. coriacea*, *H. francisiana*, *H. grammatophylla* and *H. multilineata* are very similar. *H. minyma* differs by having much smaller creamy-white flowers (pink to red in the other species).

H. bucculenta Gardn. (1936, p. 123) is allied to this group of species in that it has a raceme of similar size, shape and colour, similar fruit, but differs in that its leaves are much narrower and uni-nerved.

The mean number of veins per leaf, the standard deviation and sample size are presented below—

	Mean	St. Dev.	Sample size
H. francisiana	6.0	1.3	182
H. grammatophylla	7.1	1.4	84
H. coriacea	10.3	1.5	163
H. minyma	14.2	2.0	89
H. multilineata	15.1	3.4	156

The probabilities and t-values for difference of means between species are presented in Table 1.

TABLE 1

Species	1	2	3	4	5	
1 *H. coriacea*		28.6	15.6	16.8	17.4	
2 *H. francisiana*	$<<.001$		5.9	38.0	35.5	
3 *H. grammatophylla*	$<.001$	$<.001$		27.0	21.6	t-values
4 *H. minyma*	$<.001$	$<<.001$	$<<.001$		2.5	
5 *H. multilineata*	$<<.001$	$<<.001$	$<<.001$	$.01<P<.02$		
	Probabilities					

Thus at the 5% probability level, the sample means of all species significantly differ from each other. When the number of veins per leaf is used in combination with inflorescence length and size, pubescence on rhachis, and fruit shape, then these species can be readily separated.

Key to Hakea multilineata *and allies*

1. Leaves with one distinct central vein ..... *H. bucculenta*
1. Leaves with several to many veins 2
2. Mature fruit with distinct bicarinate ventral suture ..... *H. multilineata*
2. Mature fruit without bicarinate ventral suture 3
3. Perianth creamy white ..... *H. minyma*
3. Perianth pink to red 4
4. Rhachis of inflorescence tomentose ..... *H. grammatophylla*
4. Rhachis of inflorescence glabrous 5
5. Main veins of leaves 5 or 7 (–8). Leaves 3–6 mm wide ..... *H. francisiana*
5. Main veins (8–) 9–10 (–13). Leaves 6–16 mm wide ..... *H. coriacea*

Hakea bucculenta Gardner 1936: 123.

Holotype: Gardner 2571 (PERTH) (n.v.)

Distribution: Restricted to Western Australia from Galena in the north to Geraldton in the south (Fig. 4).

Selected Specimens: W. Aust., *Blackall* 4709, 48 km N of Galena, 18.ix.1951 (PERTH); *Gittins* 1550, 51 km S of Warroo road house, north of Geraldton, Aug. 1967 (PERTH); *Long* 25, 129 km E of Geraldton, 1.viii. 1960 (PERTH).

Hakea multilineata Meisn. 1847: 261.

Holotype: Drummond coll. III no. 275, Swan River (NY).

Isotypes: K (two sheets); MEL 1010212; MEL 1010216; PERTH.

Distribution: Restricted to an area in the

south-west corner of Western Australia (Fig. 5).

Selected Specimens: W. Aust., *Brooker* 1872, 66 km E of Brookton, 22.vii. 1969 (PERTH); *Drummond* 275, Swan River (Type) (K, MEL, NY, PERTH); *Filson* 8903, Holland's Track, 88 km SW of Coolgardie, 16.ix. 1966 (MEL); *Wilson* 3220, ca. 120 km W of Daniell on road to Lake King, 15.ix. 1964 (AD).

Hakea grammatophylla (F. Muell.) F. Muell. 1867: 214.

Basionym: *Grevillea grammatophylla* F. Muell. 1865: 25.

Holotype: "In Australia centrali prope central Mount Stuart fructicibus interspersa", *J. Macd. Stuart* (MEL 1010236).

Mueller (1867) cited R. T. Sullivan—"Gawler Ranges" and M. Weidenbach, "in vicinity of Port Lincoln", as *H. grammatophylla* but these two specimens are *H. francisiana* F. Muell. The fragmentary nature of the specimens probably explains the misidentification.

Distribution: Restricted to the ranges of central Australia (N.T.) (Fig. 5).

Selected Specimens: N.T. *Brauglehole* 23189, King's Canyon, George Gill Range, 5.vii. 1967 (NT, NSW); *Lothian* 76, Standley Chasm, July-Aug. 1954 (AD); *Maconochie* 443, Serpentine Gorge, 19.vii. 1967 (NT).

Hakea minyma Maconochie, sp. nov.

Frutex 1–2 m altus, caulibus majoribus nonnullis praeditus. *Folia* erecta, linearia, elongata, plana, laevia, glabra, rigide coriacea, 8–15 cm longa, 5–8 mm lata, a 14–17 nervis (usitate 15) lineata. *Inflorescentia* racemosa multiflora, rhachide glabra, 3–5 cm longa. Flores maturi et expansi 8–9 mm longi. *Perianthium* gilvum, glabrum; torus circa 1 mm longum, 0.5 mm latum, horizontalis vel aliquantum obliquus. Ovarium paene sessile, glabrum, 1–1.5 mm longum; stylus glaber, filiformis, 5–6 mm longus; stigma glabrum, erectum, conicum, 1 mm longum. Glans ovoideo—globosa, ad basin ovarii sita. *Fructus* ovoideo—globosus, 2–2.5 cm longus, 1–1.5 cm latus; pedicellus 1–3 mm longus vel minusculus; rostrum perconspicuum, saepe curvatum. Pericarpus laevis nisi pustulae parvae, plus minus straminicolor. *Seminis corpus* 8 mm longum; ala 1.7 cm longa, nigra, rhombiformis vel angulato-ovata, secus corpus unilateraliter decurrens.

Holotypus: *Maconochie* 846, about 84 km W of Musgrave Park Station, S. Aust. (26° 20'S; 130°30'E), 30.ix. 1969 (NT). Specimen with flowers, fruits and photograph.

Isotypi: AD, BRI, CANB, K, MEL, NSW PERTH.

H. microneura C. A. Gardner—nomen invalidum in Fairall (1970).

Shrub 1–2 m tall, with several main stems. *Leaves* erect, flat, linear, elongate, smooth, glabrous, rigidly coriaceous, 8–15 cm long, 5–8 mm wide, with 14–17 nerves (mostly 15). *Inflorescence* a raceme with numerous flowers, rhachis glabrous 3.0–5.0 cm long. Open mature flowers 8–9 mm long. *Perianth* creamy-yellow, glabrous; torus about 1 mm long, 0.5 mm broad, horizontal to slightly oblique. Ovary almost sessile, glabrous, 1–1.5 mm long; style glabrous, filiform, 5–6 mm long; stigma glabrous, erect, conical, 1 mm long. Gland ovoid-globular, at base of ovary. *Fruit* ovoid-globular, 2–2.5 cm long, 1–1.5 cm broad; pedicel 1–3 mm or less; beak strongly developed, often curved. Wall smooth with small pustules, coloured beige to light tan, the latter colour often more pronounced on beak. The beak is often lost from fruit older than twelve months and the wall becomes grey in colour. Fruit then 1.9–2.0 cm long and 1.4–1.6 cm broad. *Seed body* 8 mm long; wing 1.7 cm long, black, rhombic or angulato-ovate in shape, decurrent along one side of the body.

The specific epithet is derived from the Pitjantjatjara word minyma (woman), an allusion to the fruit's resemblance to a woman's breast.

Distribution: This species extends from the Musgrave-Mann-Petermann Range complex of South Australia and the Northern Territory down to the Tammin-Merredin area in the south-west of Western Australia (Fig. 5).

Selected Specimens: N.T. *Dunlop* 2010, 48 km NE of Mt. Davies Camp, Mann Range, 31.x. 1970 (AD, CANB, NT); *Latz* 941, ca. 129 km NE of Mt. Davies Camp, edge of Pottoyu Hills, N.T., 2.xi. 1970 (DNA, MEL, NT). S. Aust. *Eichler* 17285, between Mt. Harriet and Musgrave Park Homestead, 5.ix. 1963 (AD); *Maconochie* 846, ca. 84 km W of Musgrave Park Station, 30.ix. 1969 (Type) (NT). W. Aust. *Gardner* 839, Coolgardie, 4.x. 1920 (PERTH); *George* 2879, 35 km NE of Laverton, 23.viii. 1961 (PERTH); *George* 5639, 55 km SW of Wiluna, 29.vii. 1963 (PERTH); *Koch* 975, Cowcowing, Sept. 1904 (MEL, NSW, PERTH); *Royce* 4461, Comet Vale, 23.ix. 1953 (PERTH).

Hakea francisiana F. Muell. 1858: 20.

Type: *G. Francis*, near bay, Spencer's Gulf. Specimen probably lost (search made at AD, K, MEL).

Neotype: *B. Copley* 2345, Thurlga Station, Gawler Ranges, S. Aust. 13.x. 1968 (AD).

Fig. 2 (above). Holotype sheet of *Hakea minyma* Maconochie.
Fig. 3 (below). Holotype sheet of *Hakea coriacea* Maconochie.

H. multilineata var. *graminea* nomen invalidum in Fairall (1970).

Distribution: Widely distributed through the southern arid areas of South and Western Australia (Fig. 4).

Selected Specimens: S. Aust. *Cornwall* 56, ca. 55 km SE of Kimba, 17.vii. 1968 (AD, NT); *Ramsay* s.n., 113 km SSW of Camp 17, Elder Expedition, July 1891 (AD, NSW); *Wilson* 1573, 40 km NW of Ceduna, 11.ix. 1960 (AD). W. Aust. *Gardner* 6465, Bencubbin, 10.ix. 1942 (PERTH); *George* 5646, 122 km N of Sandstone, 29.vii. 1963 (NSW, PERTH); *Wilson* 3142 ca. 30 km SE of Londonderry, 14.ix. 1964 (AD, PERTH).

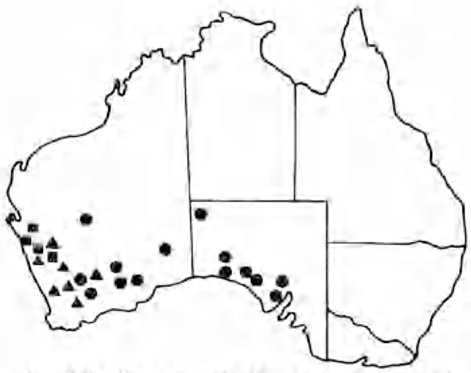

Fig. 4. Distribution of *H. bucculenta* (■), *H. coriacea* (▲), and *H. francisiana* (●).

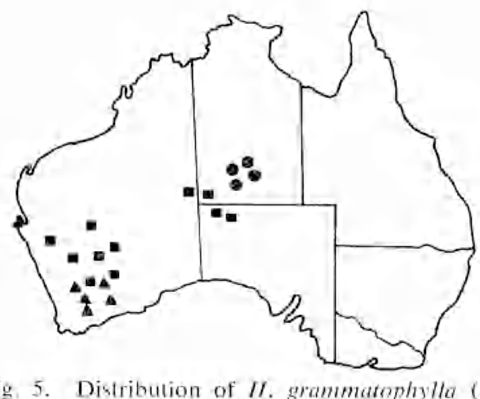

Fig. 5. Distribution of *H. grammatophylla* (●), *H. minyma* (■), *H. multilineata* (▲).

From Kangaroo I., South Australia, there have been two sterile collections made of a species close to *H. francisiana*, but until better material is available, its status is obscure.

Hakea coriacea Maconochie sp. nov.

Frutex 3–4 m altus. *Folia* linearia elongata, plana, coriacea; intervenium pubescenti, 9–20 cm longa, usitate 14–17 cm, 6–16 mm lata usitate 8–10 mm, 8–13 nervis internis plerumque 9 vel 10. *Inflorescentia* racemosa multiflora rosea vel carnea, rhachide glabra, 6–11 cm longa. *Flos* glaber 23–25 mm longus, pedicellus 2–3 mm longus, perianthium 7–8 mm, stylus glaber 19–21 mm longus, stigma glabrum, conicum 1.5 mm longum. *Torus* aliquantum obliquus, glans semi-annularis. *Bractea* glabra vel puberula, caduca, margine ciliata. *Fructus* ovoideo-globosus, circiter 18 mm longus, 12 mm latus et crassus, pericarpus laevis nisi pustulae paucae parvae vel aliquando fissuris paucis. Affinis *Hakeae francisianae* F. Muell. sed differt numero majoro nervorum et foliibus latioribus.

Shrub to 3 to 4 m high, *leaves* linear, flat, coriaceous, with a fine pubescence on the interveinal area, 9–22 cm long mostly 14–17 cm, 6–16 mm wide, mostly 8–10 mm with 8–13 nerves. *Inflorescence* pink-red, rhachis glabrous 6–11 cm long, a raceme of many flowers. Flower glabrous 23–25 mm long, pedicel 2–3 mm long, perianth 7–8 mm, style glabrous 19–21 mm, stigmatic cone 1.5 mm long. *Torus* slightly oblique, gland semi-annular. Bracts glabrous or sometimes puberulous with ciliate margin, caducous. Fruit woody, shortly pedunculate (2–3 mm) about 18 mm long, 12 mm wide and broad, wall smooth with a few small pustules or sometimes with small fissures. Closely related to *H. francisiana* but differs in greater number of nerves and wider leaves.

Holotypus: *C. A. Gardner* 12155, between Perenjori and Jibberding, W. Aust., Sept. 1953 (PERTH).

Distribution: Restricted to an area in the WSW of W. Aust. (Fig. 4).

Selected Specimens: W. Aust. *Aplin* 1983, 3 km E of Tammin, 13.ix. 1962 (PERTH); *Drummond* 18, W. Aust. (MEL, NSW); *Koch* 1018, Cowcowing, Sept. 1904 (AD, MEL, NSW); *Melville* 4265, 0.8 km W of Dalwallina, 21.vii. 1953 (AD, BRI, K, MEL, PERTH).

Phylogeny and Evolution

These species form a natural group differing from the other members of Bentham's *Hakea* sect. *Conogynoides* ser. *Longistylae* by the distinctly elongate raceme, 2–10 cm long. The other members of this series all have a more compact raceme, resulting in a more globular inflorescence.

The phylogenetic relationships of this group are uncertain:

(1) The inflorescence, leaf and fruit structure of *H. francisiana*, *H. coriacea*, *H. grammatophylla* and *H. bucculenta* indicate they probably have a common ancestor, and that *H. multilineata* and *H. minyma* may have evolved independently.

(2) The similar distribution patterns of *H. francisiana* and *H. minyma* suggest that these two species may have had a common ancestor, and *H. coriacea, H. grammatophylla, H. buccuienta* and possibly *H. multilineata* were all derived from *H. francisiana.*

The south-west province of Western Australia appears to be the focus of origin of this group of species, as five of the six species occur there and the distribution tends to radiate from there into the more arid areas to the north and east.

The two records of *Hakea* cf. *francisiana* for Kangaroo Island suggest that, during an earlier geological period, Kangaroo Island acted as a migration bridge between Eyre and Yorke Peninsulas and Fleurieu Peninsula. Wood (1930) refers to this connection and regards it as recent in geological time.

The implication of these observations is that either (1) this group of species may have evolved, diversified and migrated during the period of a land connection between the Eyre and Fleurieu Peninsulas or, (2) this was a period of rapid spread of *H. francisiana.*

The restricted distribution of *H. grammatophylla* to the ranges of central Australia and the distributional pattern of *H. francisiana* would indicate a north-eastern migration route from the south-west province of Western Australia. Subsequent periods of aridity would permit speciation to occur as there was a retreat to more favourable habitats.

Acknowledgements

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